

The background is a blue gradient. On the left side, there are white circuit-like lines with small circles at various points. In the upper center, there is a faint, glowing white circle with concentric rings around it.

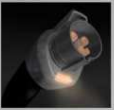
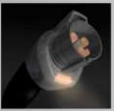
# LEVEL 1 VS. LEVEL 2

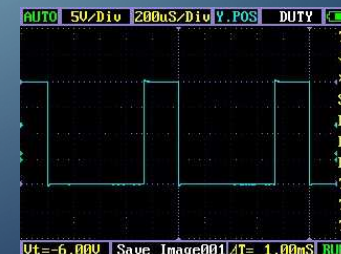
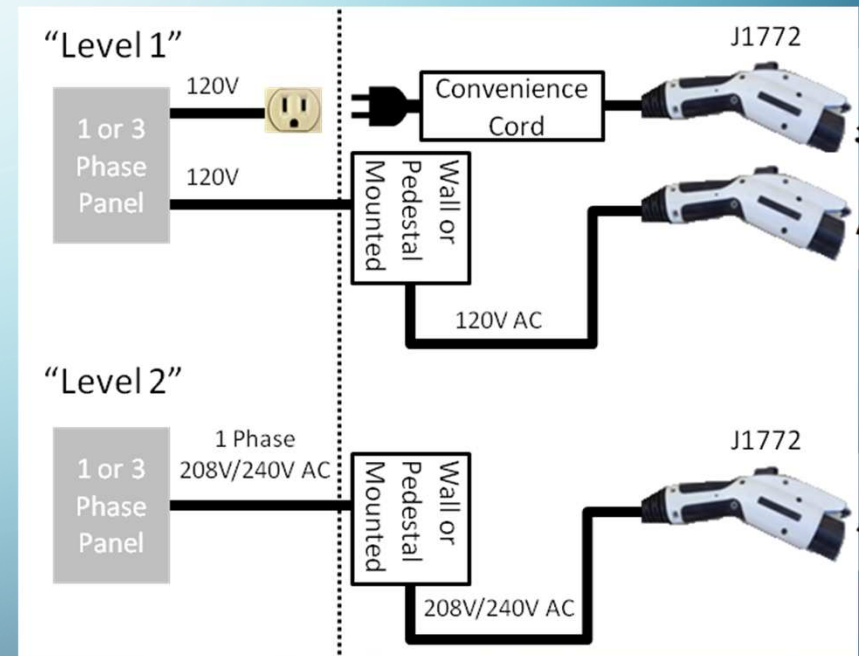
MICHAEL NICHOLAS

GIL TAL

THOMAS TURRENTINE

# WHAT THE DIFFERENCE BETWEEN LEVEL 1 AND LEVEL 2?

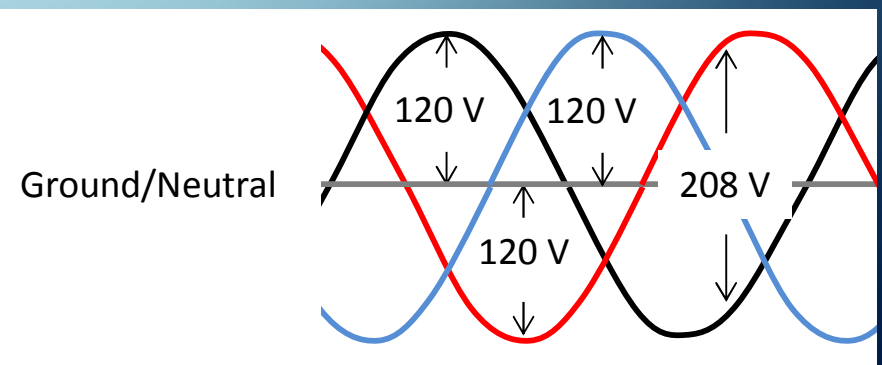
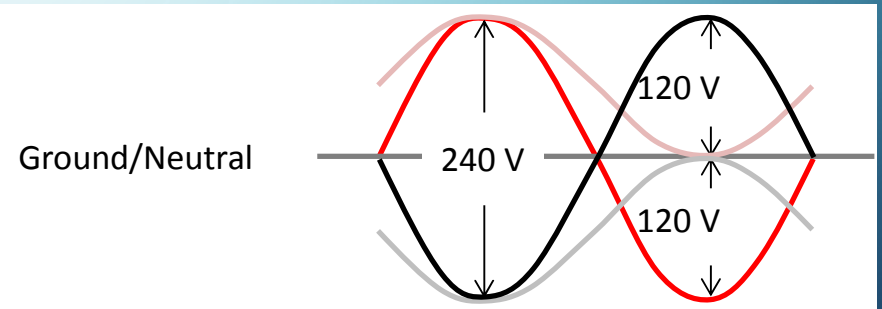
<b>AC level 1</b> (SAE J1772™)  <b>120V</b>  	PEV includes on-board charger 120V, 1.4 kW @ 12 amp 120V, 1.9 kW @ 16 amp Est. charge time: PHEV: 7hrs (SOC* - 0% to full) BEV: 17hrs (SOC - 20% to full)
<b>AC level 2</b> (SAE J1772™)  <b>208V or 240V</b>  	PEV includes on-board charger (see below for different types) 240 V, up to 19.2 kW (80 A) Est. charge time for 3.3 kW on-board charger PEV: 3 hrs (SOC* - 0% to full) BEV: 7 hrs (SOC - 20% to full) Est. charge time for 7 kW on-board charger PEV: 1.5 hrs (SOC* - 0% to full) BEV: 3.5 hrs (SOC - 20% to full) Est. charge time for 20 kW on-board charger PEV: 22 min. (SOC* - 0% to full) BEV: 1.2 hrs (SOC - 20% to full)



• <http://www.sae.org/smartgrid/chargingspeeds.pdf>

# SINGLE SPLIT PHASE VS. THREE PHASE

- **I'm not an electrical engineer but...**
- **Single Split Phase (residential)**
  - **240V between black-red**
  - **120V between red-neutral**
  - **120V between neutral-black**
- **Three Phase (commercial)**
  - **208V between black-red, black-blue, blue-red**
  - **120V between neutral and other colors**





# HOW MUCH POWER IN THE PANEL?

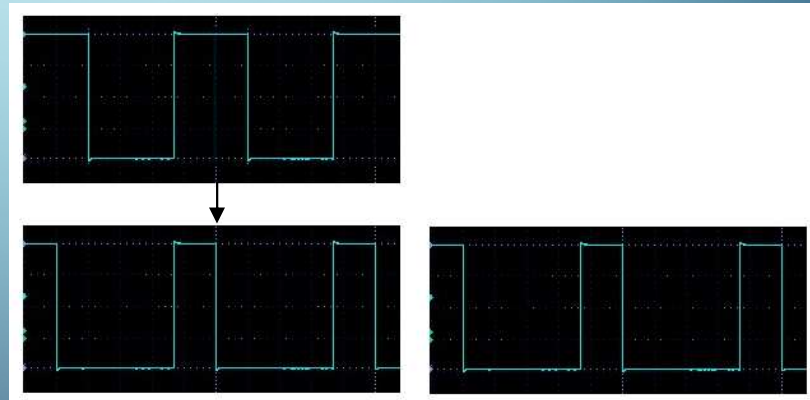
- **Single split phase (120/240) common at residential**
  - 200A Panel:  $200A \times 240V = 48kW \times 80\% = 38.4kW$
  - How many **Level 1** 1.9kW chargers?
    - $38.4kW / 1.9kW = 20$
  - How many **Level 2** 6.6kW chargers?
    - $38.4kW / 6.6kW = 5-6$
- **Three phase common in commercial and office**
  - 200A Panel:  $200A \times 208V \times \sqrt{3} = 72kW \times 80\% = 57.6kW$
  - How many **Level 1** 1.9kW chargers?
    - $57.6kW / 1.9kW = 30$
  - How many **Level 2** 6.6kW chargers?
    - $57.6kW / 6.6kW = 8-9$

# LEVEL 1 OR LOW POWER LEVEL 2?

- **Levels are about voltage, not power. 1.5kW L1 = 1.5kW L2**
- **Level 1 is not only an outlet can be hardwired**
- **Pros of level 1**
  - **Less bulky breakers. Only takes one “slot” in the panel. L2 takes 2 slots**
- **Pros of low power level 2**
  - **Smaller wire size, fewer amps**
  - **Slightly more efficient in the vehicle side on some vehicles**
  - **Possibility of power splitting**

# POWER SPLITTING

- One higher power level 2 (6.6kW? 32A@208V) can be split among multiple connectors. Maybe 4 1.6kW chargers?
- Pilot signal on EVSE changes depending on how many vehicles are plugged in
- Car constantly monitors and adjusts amperage based on this signal



# WORKPLACE NEEDS FOR HIGH POWER

- **80% of workplace employees only need 1.6kW**
- **Many vehicles can only use 2-3kW. 6.6kW is wasted**

Charging Level	Charger Power	Miles Gained/Hour				
		Plug-in Prius	Chevrolet Volt	Ford C-Max Energi	Nissan Leaf	Tesla Model S
Level 1 120V AC	1.4kW	3-5 mi	3-5 mi	3-5 mi	3-5 mi	3-5 mi
Level 2 208V-240V AC	1.4kW	3-5 mi	3-5 mi	3-5 mi	3-5 mi	3-5 mi
	3.3kW	6 mi	10 mi	10 mi	10 mi	10 mi
	6.6kW	6 mi	10 mi	10 mi	20 mi	20 mi
	10kW	6 mi	10 mi	10 mi	20 mi	30 mi
DC Fast Charger 200-400V DC	50 kW	x	x	x	65 mi in 30 minutes	65 mi in 30 minutes



# POWER SPLITTING VS. MIX OF HIGH AND LOW POWER

- **Both provide benefits over a pure L2 strategy**
- **Power splitting Pros**
  - One electrical connection with multiple J1772 connectors may save cost on installation
  - Option for drivers to get higher power perhaps if they pay more
  - Central administration in one unit
  - Less panel space than high – low mix
  - Allows two shift workplaces to maximize charging. 10 morning 10 evening
- **High – low power mix Pros**
  - More parking lot distribution can reach more spaces
  - Devices can be cheaper in the near term



# CONCLUSIONS

- **Level 1 and low power level 2 are very similar**
- **Many cars can't use full 6.6kW and many don't need it based on commute distance and dwell time**
- **Choosing depends on installation costs, panel space, parking situation**
- **Power splitting gives the same ability to increase the number of cars charging at once and also allows current behavior of midday vehicle switching. Midday switching could be good for “two shift” workplaces**